International Journal of Earth, Energy and Environmental Sciences
ISSN: 2517-942X
Vol:8, No:9, 2014

Assessing Nutrient Concentration and Trophic Status of Brahma Sarover at Kurukshetra, India

Shailendra Kumar Patidar

***Abstract*—**Eutrophication of surface water is one of the most widespread environmental problems at present. Large number of pilgrims and tourists visit sacred artificial tank known as “Brahma Sarover” located at Kurukshetra, India to take holy dip and perform religious ceremonies. The sources of pollutants include impurities in feed water, mass bathing, religious offerings and windblown particulate matter. Studies so far have focused mainly on assessing water quality for bathing purpose by using physico-chemical and bacteriological parameters. No effort has been made to assess nutrient concentration and trophic status of the tank to take more appropriate measures for improving water quality on long term basis. In the present study, total nitrogen, total phosphorous and chlorophyll a measurements have been done to assess the nutrient level and trophic status of the tank. The results show presence of high concentration of nutrients and Chlorophyll a indicating mesotrophic and eutrophic state of the tank. Phosphorous has been observed as limiting nutrient in the tank water.

***Keywords*—**Brahma Sarover, eutrophication, nutrients, trophic status.

I. Introduction

EUTROPHICATION of surface water sources is enrichment with plant nutrients, mainly phosphorus (P) and nitrogen (N). The term “Trophic” refers to feeding, and “Eutrophic” means well nourished. The use of nitrogen and phosphorous has increased for agriculture, industrial and domestic purposes and has eventually enhanced contribution to various water sources. Eutrophication creates many problems and affects overall use of surface water sources. Eutrophication of surface water sources is one of the most widespread environmental problems at present. The impaired water quality threatens existence of many organisms and human societies because clean and fresh water is essential for them. Depending on total phosphorous and chlorophyll a concentration, surface water source is classified as ultra-oligotrophic, oligotrophic, mesotrophic, eutrophic and hypereutrophic [1], [2]. In India, a number of studies have been carried out to assess physical, chemical and biological water quality, sources of pollution, pollution level, and trophic status of various water sources. River water quality monitoring has indicated grossly polluted stretches in major rivers which are due to discharge of sewage containing nutrients nitrogen, phosphorous and potassium. Presence of high concentration of nutrients N and P, phytoplankton, toxic cyanobacteria, excessive growth of algae and water hyacinth along with other aquatic weeds is reported in many lakes, ponds and reservoirs. Some lakes are reported to be fast approaching eutrophic and dystrophic conditions. Presence of toxic cyanobacteria has been reported in many water sources. Biomonitoring by Central Pollution Control Board (CPCB) has indicated moderately polluted (Class C), heavily polluted (Class D) and even severely polluted (Class E) water quality of many lakes, ponds, reservoirs and river stretches in various parts of the India [3], [4]. Various aspects of eutrophication problem with an overview of Indian scenario have been discussed in detail elsewhere [5].

A sacred manmade tank named “Brahma Sarover” is located at Kurukshetra, India. Large number of pilgrims and tourists take holy dip in the tank on auspicious days of new moon and solar eclipse. It is believed that taking holy dip in this sacred tank during these days brings blessings and salvation from all sins. Lacs of people took bath in this sacred tank and other nearby sacred tank (Sannihit Sarover) on the occasion of solar eclipse in August 2008, July 2009 and January 2010. The tank is a quadrangular with an arrangement to drain water by gravity flow for lowering water level by 90 cm. The water in the tank is replenished using water from Bhakra irrigation canal. The tank is divided in two parts namely Eastern and Western Brahma Sarover. The Size of Eastern and Western Brahma Sarover is 540 × 450 × 4.5 m and 450 × 450 × 4.5 m, respectively. The approximate water holding capacity of Eastern and Western Brahma Sarover is 1140000 and 910000 m3, respectively. Bathing platforms with protective railings have been constructed along the periphery of the tank. Exclusive separate and covered bathing areas have been constructed for use of women pilgrims. Water quality assessment of the tank on the occasion of mass bathing during solar eclipse has indicated unsatisfactory water quality. The biochemical oxygen demand (BOD) and total coliform values have been observed to be higher than the requirements for outdoor organized mass bathing [6], [7]. The deterioration in water quality with high coliform counts during mass bathing is mainly due to various religious offerings such as coins, milk, curd, sweets, coconut, oil/butter oil, flowers, fruits, vegetable leaves, wheat flour, rice, hair and cremation ash to the water body. The water quality of the tank is improved before auspicious occasions by partial draining of polluted water and refilling with water from nearby sacred tank, cleaning of bathing platforms by removing algae growth, and using coagulant such as alum.

Visual observations indicate growth of algae with floating algal blooms in the tank water on many occasions. Studies done so far have assessed only physico-chemical and

Shailendra Kumar Patidar is with the National Institute of Technology, Kurukshetra, India (phone: 91-1744-233351; fax: 91-1744-238050; e-mail: skpatidar@nitkkr.ac.in).

bacteriological quality of water. No effort has been made to assess nutrients level and trophic status of tank for taking more appropriate measures for improving water quality. In the present study, total nitrogen, total phosphorous and chlorophyll a have been measured to assess nutrients level and trophic status of the tank.

II. Materials and Methods

The layout plan of the tank along with sampling locations is shown in Fig. 1. The sampling was done on monthly basis during July 2008 to March 2010 for total nitrogen (TN) and total phosphorous (TP) from four locations in each part of the sacred tank. For Chlorophyll a, sampling was done on monthly basis from December 2008 to March 2010 from two locations in each part of the sacred tank. The samples were transported immediately to environmental engineering laboratory, National Institute of Technology, Kurukshetra for analysis. During transportation, the samples were kept at low temperature in an insulated sampling box. The samples were analyzed for total nitrogen, total phosphorous and chlorophyll a as per Standard Methods [8]. A UV-Visible Spectrophotometer, model UVS 2700, make Labomed USA was used for the analysis.

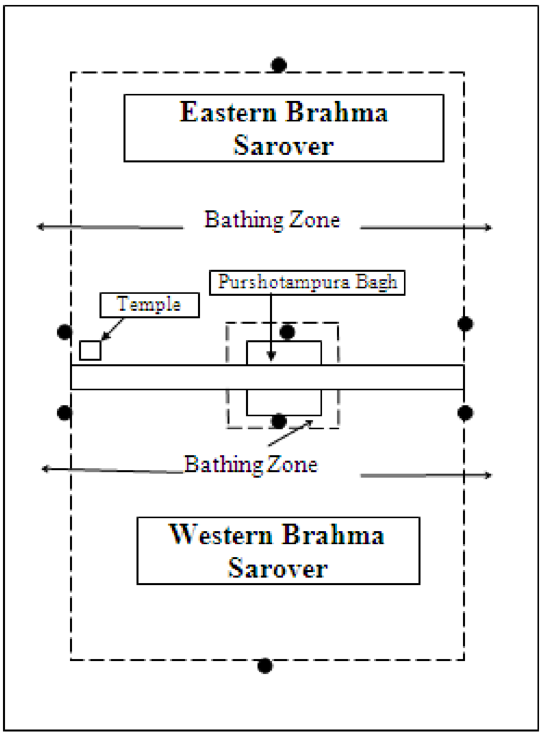

Fig. 1 Layout plan of Brahma Sarover (Sampling Locations ●)

III. Results and Discussion

The total nitrogen, total phosphorous, and Chlorophyll a have been measured in samples from number of locations, and average values have been calculated. The total nitrogen, total phosphorous and chlorophyll a values as observed on monthly basis are presented in Figs. 2, 3, and 4, respectively.

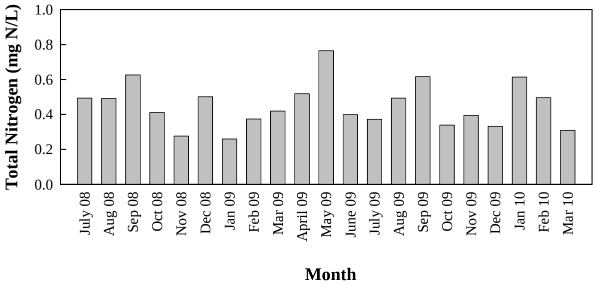

Fig. 2 Monthly variation in total nitrogen concentration

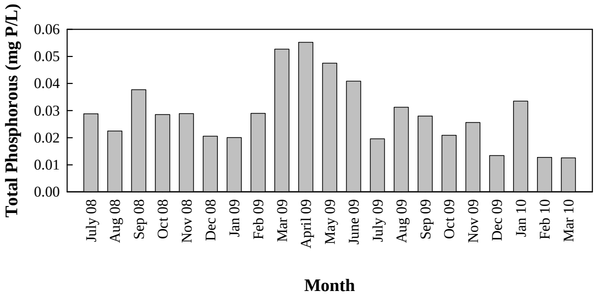

Fig. 3 Monthly variation in total phosphorous concentration

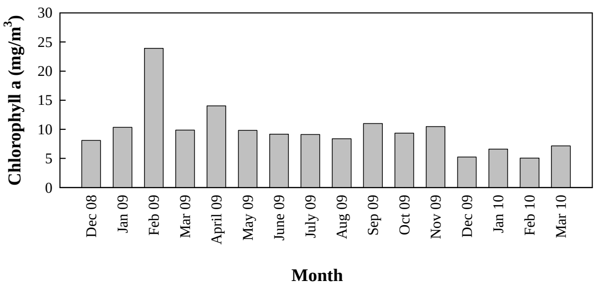

Fig. 4 Monthly variation in chlorophyll a concentration

A. Total Nitrogen

Variable total nitrogen concentration has been observed during the study (Fig. 2). High total nitrogen concentration of 0.61 – 0.76 mg N/L has been observed in the months of September 2008, May 2009, September 2009 and January 2010. Low total nitrogen concentration of 0.26 – 0.28 mg N/L has been observed in the months of November 2008 and January 2009.

B. Total Phosphorous

Variable total phosphorous concentration has been observed during the study (Fig. 3). High total phosphorous concentration of 0.038 – 0.055 mg P/L has been observed in the months of September 2008 and March 2009 to June 2009. It indicates eutrophic state of tank. Low total phosphorous concentration of 0.013 mg P/L has been observed in the months of December 2009, February 2010 and March 2010. The average total phosphorous concentration at sampling location near temple was highest during the study.

International Journal of Earth, Energy and Environmental Sciences
ISSN: 2517-942X
Vol:8, No:9, 2014

C. Chlorophyll a

Variable chlorophyll a concentration indicating variable algae growth has been observed in the tank during the study (Fig. 4). High chlorophyll a concentration of 8.1 – 23.9 mg/m^3 has been observed during the period from December 2008 to November 2009. It indicates eutrophic status of the tank. Low chlorophyll a concentration of 5.1 – 7.2 mg/m^3 indicating mesoeutrophic status has been observed during the period from December 2009 to March 2010.

The overall results of the study are summarized in Table I. Based on the results presented in Table I, following observations have been made: (a) average total nitrogen, total phosphorous and chlorophyll a concentrations were 0.385 – 0.602 mg N/L, 0.024 – 0.038 mg P/L, and 8.7 – 10.6 mg/m^3, respectively; (b) overall average total phosphorous indicate mesotrophic and chlorophyll a concentration indicate eutrophic status of the tank; (C) average N/P ratio ranged from 13.8 – 17.3 at various sampling locations with overall average value 16.0.

TABLE I
SUMMARY OF TOTAL NITROGEN, TOTAL PHOSPHOROUS AND CHLOROPHYLL A RESULTS AT VARIOUS SAMPLING LOCATIONS OF BRAHMA SAROVER

	Sampling Location	Total Nitrogen (mg N/L)		Total Phosphorous (mg P/L)		TN/TP Ratio	Chlorophyll *a* (mg/m^3)	
		Av ± Std. Dev	Range	Av ± Std. Dev	Range	Av.	Av ± Std. Dev	Range
Western Brahma Sarover	1	0.447 ± 0.162	0.268 - 1.075	0.026 ± 0.017	0.003 - 0.071	16.9	-	-
	3	0.450 ± 0.207	0.228 - 1.209	0.028 ± 0.015	0.008 - 0.058	16.1	-	-
	5	0.493 ± 0.215	0.206 - 0.998	0.031 ± 0.019	0.007 - 0.082	16.0	8.7 ± 5.9	2.1 - 28.6
	6	0.385 ± 0.165	0.169 - 0.954	0.028 ± 0.024	0.007 - 0.118	13.8	8.9 ± 7.0	1.8 - 34.7
Eastern Brahma Sarover	7	0.389 ± 0.143	0.180 - 0.788	0.024 ± 0.012	0.008 - 0.063	15.9	10.6 ± 6.1	3.2 - 28.8
	8	0.602 ± 0.325	0.232 - 1.469	0.038 ± 0.020	0.011 - 0.092	16.0	10.4 ± 6.2	3.1 - 26.0
	10	0.494 ± 0.221	0.260 - 1.331	0.030 ± 0.013	0.009 - 0.063	16.3	-	-
	12	0.442 ± 0.264	0.215 - 1.561	0.025 ± 0.012	0.005 - 0.049	17.3	-	-
Overall		0.463 ± 0.229	0.169 - 1.561	0.029 ± 0.017	0.003 - 0.118	16.0	9.7 ± 6.4	1.8 - 34.7

Nitrogen and phosphorous are essential nutrients and these are taken up by phytoplankton at an atomic ratio of 16:1 or mass/concentration ration of 7.2:1. If available amount differs widely from this ratio, a limitation to growth occurs. In the present study, ratio of total nitrogen and total phosphorus is observed in the range of 13.8 – 17.3 which indicates that phosphorous is a limiting nutrient. The total nitrogen and total phosphorous concentration is high in Brahma Sarover water and internal cycling of these nutrients supports persistent growth of algae. This contributes to poor aesthetic water quality of Brahma Sarover. The decay of algal biomass results in high organic content, odour nuisance, high BOD and high bacterial count. The root cause of poor water quality throughout the year is high nutrients concentration and their internal cycling. Problem of eutrophication needs to be given due consideration for improving and maintaining water quality of the sacred tank. In the present study, poor correlation between nutrients level and chlorophyll a has been observed due to random human interventions in the form of (a) temporary water quality improvement measures such as partial draining and refilling of water, cleaning of bathing platforms, use of alum, etc., and (b) addition of impurities through bathing and religious offerings.

IV. CONCLUSION

The sacred Brahma Sarover water contains high nitrogen and phosphorous concentration, and phosphorous is the limiting nutrient. The tank has mesotrophic and eutrophic status during the study. The external addition of nutrients and internal cycling of nutrients both lead to algae growth and consequently poor water quality almost throughout the year.

The water quality improvement measures should address eutrophication issue for ensuring better water quality on long term basis.

Acknowledgment

This study has been supported by the Department of Science and Technology, Govt. of India under NRDMS programme.

References

[1] R. A. Vollenweider and J. Kerekes, Eutrophication of waters: monitoring, assessment and control. Paris: Organization for Economic Co-operation and Development (OECD), 1982.
[2] R. G. Wetzel, R. G., *Limnoloy*. New York: Academic Press, 2001.
[3] CPCB, *Bio-monitoring of water bodies, Part-II, Parivesh Newsletter*. New Delhi: Central Pollution Control Board, 2002.
[4] CPCB, *Bio-monitoring of wetlands in wild life habitats of India. Part-I: birds sanctuaries, Parivesh Newsletter*. New Delhi: Central Pollution Control Board, 2003.
[5] S. K. Patidar, "Problems and prospects of eutrophication control,". *Journal of Indian Association for Environmental Management*, vol. 36(1),pp. 47-51, 2009.
[6] CPCB, *Water quality assessment during solar eclipse mass bathing at Brahm Sarover, Kurukshetra (Haryana), ADSORBS/31/1999-2000*. New Delhi: Central Pollution Control Board, 2000.
[7] S. K. Patidar, "Effect of mass bathing on water quality of Brahma and Sannihit Sarovers," *A paper presented in the International Conference on Water-Harvesting, Storage and Conservation*, Indian Institute of Technology, Kanpur, India, November 23 - 25, 2009.
[8] APHA, AWWA, WEF, *Standard methods for the examination of water and wastewater*. 21st edn, Washington DC: American Public Health Association/American Water Works Association/ Water Environment Federation, 2005.